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The American Biology Teacher

Vol. 7 MARCH, 1945 No. 6

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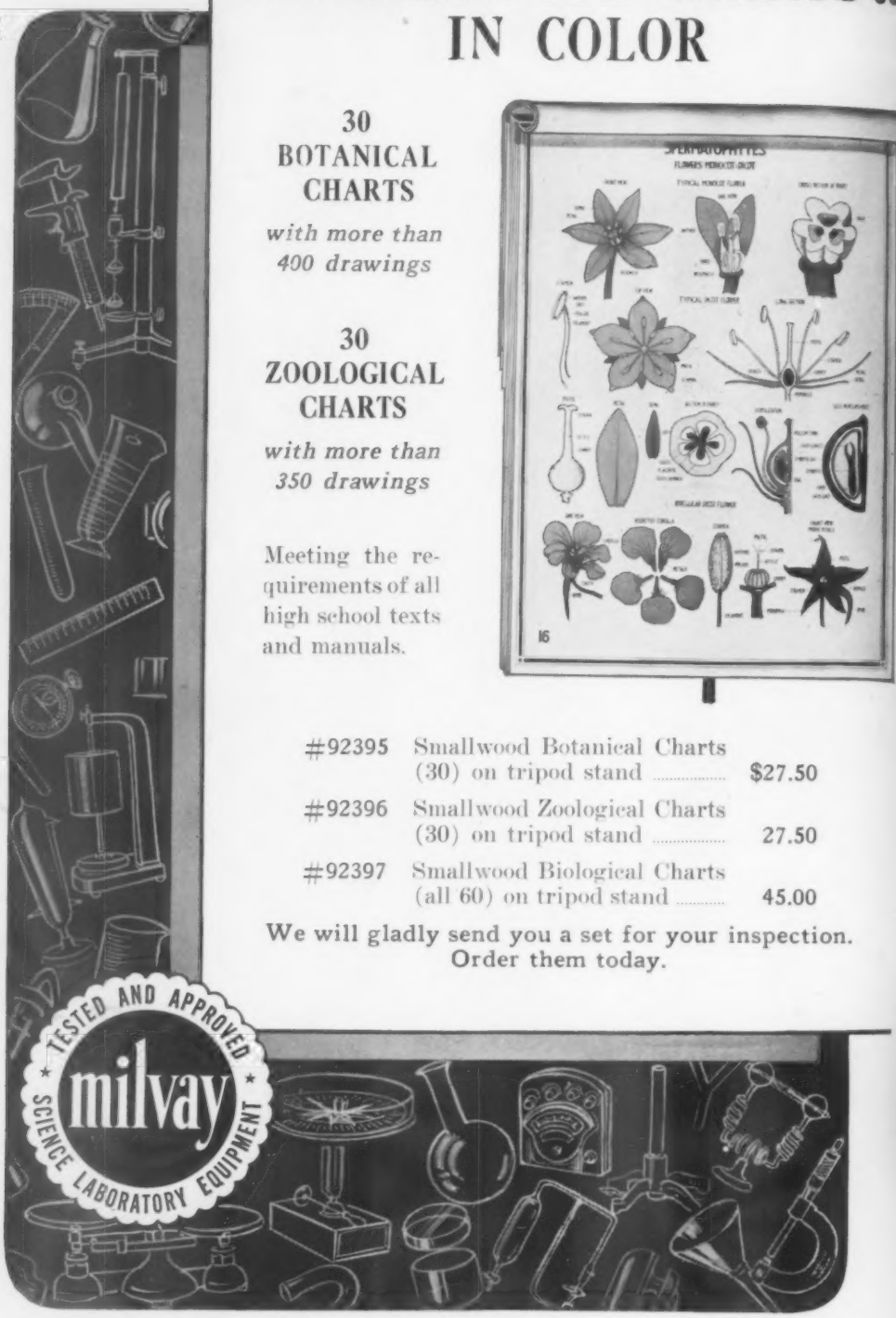

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The American Biology Teacher

Vol. 7 MARCH, 1945 No. 6

Teaching Heredity the Scientific Way

JESSE V. MILLER
Manhasset High School, Manhasset, New York

Scientists often have to wait until their experiments are completed before they know what results to expect. Do you give your students an opportunity to experience the feeling of accomplishment that comes from *real* experimentation? Do you have a hard time prying many of them from your laboratory at the end of the period? Is your arm tired from writing passes for students who need "a few more minutes" at the period's end?

If you already are in the throes of such experiences, you probably still would not mind adding a few more such projects to your special list. Try using fruit flies (*Drosophila*) as a starter, and get some of the types not written up commonly in textbooks.

What characters are *best* for students and teachers who have never worked with fruit flies before? No one can answer that question with finality, but a year of experimentation on your part, along with your students, will probably give you a satisfactory answer. Try some *Wild Type* flies (they have red eyes, long wings, light-colored bodies); some wing mutant types such as *Dumpy* (with wings about ¾ length, squarish at tips); *Miniature* wings (wings narrow and not full length); *Vestigial* wings (they have such stubby wings that they cannot fly). Try also some mutant eye traits. *Bar* eyes are interesting, as are *White* eyes (these white eyes are in most textbooks, sex linked). The *Ebonys* are lively and easy to raise (they have *dark bodies,* red eyes, and long wings).

At first you will need to demonstrate procedures to each group or individual, but gradually students will take over all of the work. Organize a laboratory squad to keep the stock cultures in order and to prepare new breeding bottles ahead of actual needs. Suggest additional crosses for the more interested, and as the students learn to make the simpler combinations, help them to compare the work they are doing with the

problems of the animal breeder. Have the *scientists* among your groups (as advanced projects) try to combine 3 recessives in one individual by breeding, as though this were a valuable accomplishment and the 3 traits in combination a great contribution to the welfare of the world. This might be compared to 3 valuable recessives residing in 3 different sheep or dairy cattle. The problem is to get them all together in single individuals so the combination can be propagated.

Students might try to combine bar eyes, ebony body, and dumpy wings. Leave out the ebony body and the problem is much simplified. They may choose to "lose" 2 characters temporarily, then try to recover them in the F_2 generation in the 9–3–3–1 chance. This is a fine opportunity to really see *independent assortment* at work.

Students should be able to work out theoretical results (hypotheses) based on their knowledge of Mendel's experiments. This should be done for even the simpler experiments. Use Punnett squares or other diagrams to show expected results, then compare *actual* results with these *expected* results. They will often not agree. Students then meet the same obstacles scientists meet and have to solve. If one of the 2 or 3 females used for the F_1 cross was *not* virgin, how would that influence the results? Make the crosses which might be involved on Punnett squares and see what theoretical ratios would result. What if one of the males used were a hybrid, how would that influence the results? Students need help on these problems when making their first crosses—give them only stock that is pure, females that are virgin. In the later experiments allow them to make a few mistakes in the name of good education, then have them figure out (without help if possible) why their results were not according to expectations. In this way teach them, among other things, the necessity for extreme care in experimentation.

And now what about equipment? All sterilization can be done in boiling water. A cooking pan and a source of heat will complete the sterilization equipment. Use bottles that hold about an ounce or so. Shell vials are handiest if you buy the glassware, 23×85 mm. or slightly larger. You need a large package of *sterile* cotton to plug the bottles, some high grade paper towelling such as Scott's rolls for inside the bottles.

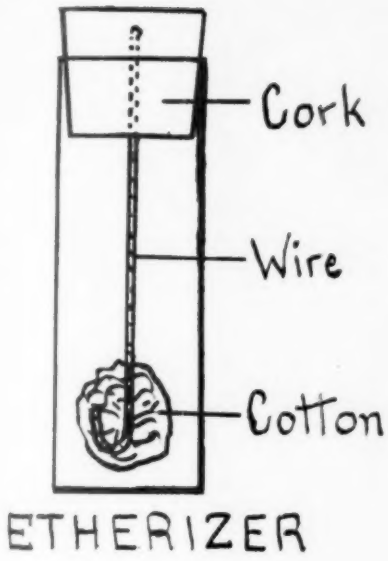
A can of ether will serve to slow the fruit flies down for handling. For a class of 25 or so, a 5-lb. can is about right. Some dropper bottles such as nose drops come in can be secured from any drug store. These are used as ether bottles for students. Any hand lens or magnifier is useful in examining the flies. You'll need about 2 ounces of Moldex.[1] This will keep the molds under control if used along with all other precautionary measures such as sterilization of all instruments and bottles. I even soak the paper toweling in a 2% Moldex solution (in 95% alcohol). Let the towelling dry before inserting into bottles.

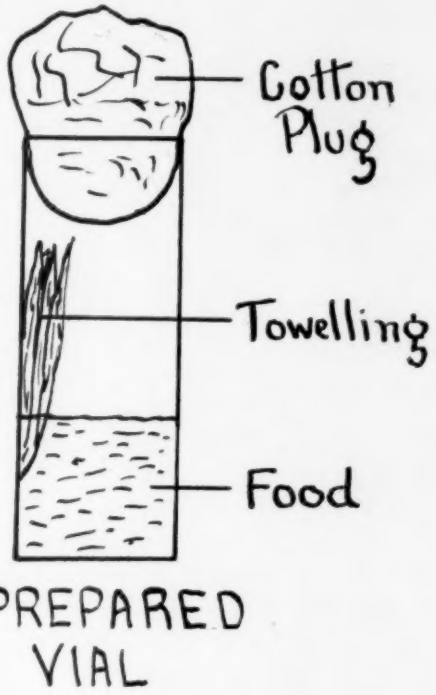
"Slumber chambers" are made from Petri dishes.[2]

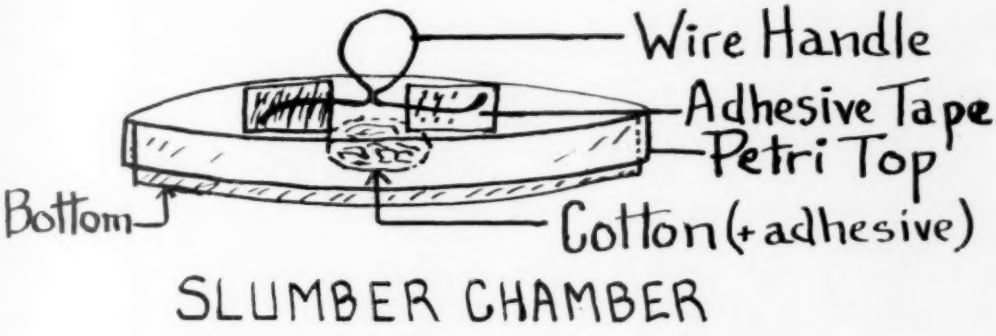
Stock bottles may be half-pint milk bottles; the smaller bottles will do, but require reculturing more often. Use the same bottles for etherizing as you use for crosses and stock (2 sizes); push a piece of wire through a cork which fits each bottle so that the wire just touches the bottom of the bottle when the cork

[1] *Glyco Products Co.*, 148 Lafayette Street, New York City, manufacturers; may be obtained from various biological supply houses.

[2] If a piece of white paper is used as a bottom, either half may be made into a "top." Otherwise attach handle and cotton to larger half.







is inserted. Bend a little loop in the bottom end, and tie a wad of cotton into this loop. Drop ether on this to anaesthetize the flies.

Culture medium may be mashed overripe bananas (not *rotten*), or prepared medium. Fill the vials about 1 in. deep with either preparation. Use Moldex in either case. Place folded, treated towelling and 2 drops (3 or 4 in large cultures) of thick "store" yeast (in water) on the medium in each jar, then stopper with sterile cotton. Make crosses at once, or keep prepared bottles in refrigerator until needed. Don't drop flies into the sticky yeast.

If you use prepared corn-meal-yeast medium you will need a box of yellow corn meal, a jar of dark molasses (SO_2-free if possible), 1 lb. dried yeast, some agar (or try gelatin), Moldex, and a live yeast cake. Be sure the bottles are cool before adding yeast.

Complete directions may be obtained

by writing *The Carnegie Institution of Washington*, 1530 P Street Northwest, Washington 5, D. C. Ask for a *Drosophila Guide*. A corn-meal-yeast medium is described in this booklet. Booklets sell for 25¢ each.

Drosophila (fruit fly) cultures may be obtained from almost any college genetics laboratory, or the *Carnegie Institution* will give you a few along with the booklet. Biological supply houses sell cultures of most types, and other schools in your vicinity will probably be glad to give you some breed-stock if you will send a student with some prepared bottles.

Now what about "Gremlins"? An aquarium with a cardboard top will serve as an excellent incubator. Heat is supplied by an electric light bulb mounted in a tin can. Punch a hole through the bottom of a quart can to insert socket. The flies want subdued light, not strong light. White paper on the sunny side of the aquarium will regulate this. Maintain a temperature between 70 and 80° for most rapid development of cultures.

Be careful not to drop etherized flies into the culture medium itself. Grasp flies by their wing tips with eyebrow tweezers, lay them on the towelling, and leave the bottles on their sides until the flies recover. Always keep the bottles stoppered with cotton except when removing flies or making crosses. This helps to prevent the escape or entrance of unwanted flies, and keeps out mold spores. Our main headaches have been: 1. Cultures spoiled by *mold growth;* 2. Too great *temperature variation*, especially if accompanied by *drafts;* 3. Flies *drowned* in the medium due to falling in while still etherized; 4. Medium *too wet* on the surface. Facial tissues are too absorbent and stay wet. We had trouble while we used these. Flies with wings folded over the back or under side of the body are usually dead. If in doubt, place flies for crosses in clean bottles without food until they recover. Use cotton as a plug.

If you haven't tried experimenting with these insects you have a real treat in store. Don't worry if you know nothing about the work. That is probably for the best, because then you can truthfully say "I don't know" to the questions asked by students which can be answered by the experiments themselves. Besides, it's good fun to work along with the students, the flies are easy to propagate, and there is nothing difficult in the procedure. The expense involved is small, even the first year, and success is assured. Your classes can see living animal eggs by dissecting gravid females. A great variety of scientific principles can be experienced first hand. This is real science.

BY THE WAY

THE "DIME STORE" should not be overlooked as a source of laboratory aids and substitutes—seeds, potted plants, nature booklets, aquarium specimens, window shades for charts or projection screens, glass dishes for protozoan cultures—to mention a few.

PLACE A POTTED PLANT a few feet from a window and note the arrangement assumed by the leaves, with reference to the direction of the light. Then turn the plant around and see how long it takes for the leaves to turn so that they face the window again.

FROG EGGS will hatch in an aquarium if there is plenty of oxygen and light. If the hatch is successful, remove a few tadpoles each day and preserve in 10% formalin. Thus a series, illustrating the growth stages of the frog, may be built up.

PLANT SEEDS in several different types of soil, or in soil treated with various types of fertilizer, keeping other conditions as nearly uniform as possible; note differences in growth and vitality of the plants.

What Is Heredity?*

THEODOSIUS DOBZHANSKY
Columbia University, New York City

The discussion in *Science* precipitated by the statement of Professor Dice, that "the characters of man that are inherited include not only his anatomical features, but also his physiology and his psychology," has served to emphasize the need of clarification of the concept of heredity. Expressions like "inherited skin color" or "inherited behavior" are figures of speech which are misleading if taken literally. The relations between heredity and characters or traits of the developing organism are dynamic. Heredity does not transmit skin colors or behaviors; it determines the responses, the norm of reaction, of the organism to its environment.

The same heredity in different environments may give rise to different skin colors and behaviors. Diabetes mellitus is inherited, but injections of insulin remove the manifestations of this physiological disorder. Insulin obviously does not "cure" or alter the defective heredity; but this heredity responds to an environment which contains insulin by normal carbohydrate metabolism. Now, it is not too much to suppose that a diabetic will in some cases behave differently from a non-diabetic. The former is likely to adhere to a certain regimen which might, for example, limit his social activities. He may be reluctant to embark on a journey in parts where he is not sure to find a supply of insulin. His whole personality may acquire a special cast which in the last analysis is due to the possession of genes for diabetes. A Negro, or for that matter anybody having a highly pigmented skin, may be diffident or aggressive in a social environment in which his pigmentation subjects him to discrimination and handicaps. This "psychology" may correctly be called inherited, just as the skin color is called inherited, although in some people the skin color is greatly changed by exposure to sunlight. Heredity which causes the skin to be black and behavior self-conscious may result in a quite different behavior in an environment where discrimination is absent.

Non-geneticists may feel disinclined to regard as hereditary a trait so plastic that it appears in some environments but not in others. Yet, all degrees of environmental plasticity occur. For example, the A–a^B–a blood group genes produce the same "character" in all known environments. The outward manifestations of the genes for eye color slightly changes with age. The environmental dependence of stature, weight and skin color is obvious. Behavior is influenced so much by environmental variables, particularly training, social conditions and accumulated experience, that the genetic variable is frequently masked. The designation "hereditary" can not be restricted to traits which show a certain degree of constancy of expression. The degree of constancy is itself inconstant; introduction of insulin treatments made the expression of the genes for diabetes much more labile than it was. It may seem trite to remind that genes influence the development through chains of physiological reactions. The possibilities of controlling the gene manifestation will be greatly increased when these reactions become known. Theoretically, the action of any gene may be

* Reprinted, with minor changes, from *Science*, Vol. 100, p. 406, Nov. 3, 1944.

controlled. To say that man's psychology is inherited does not, by any stretch of imagination, mean that it is fixed and unalterable. We can not change our heredity directly, but heredity is not implacable destiny to which one must submit in resignation. We should seek for ourselves, and contrive for others, environments in which our heredities respond most favorably. If the genotypes of all men responded to every given environment by producing the same "psychology," we could say that psychic characters are not inherited. This, I take it, is not contended even by most confirmed environmentalists. On the other hand, the assertion that psychic characters are inherited does not preclude the possibility that we can, by proper manipulation of the environment, eventually achieve a complete control over them.

Existence of inherited "race psychology" is a wholly separate problem. Races are defined as populations differing from each other in the incidence of certain genes. Physical characters suggest that there are all degrees of racial subdivision, beginning with social isolates, local populations and up to the major races the reality of which is not impaired by intermediate or doubtful groups. Theoretically, it is possible that, although genetic variation in psychic characters exists from individual to individual, the incidence of all the variants in the several races is alike. Secondly, it is possible that races differ in the incidence of some of these variants but that the differences are purely quantitative. Finally, it is possible that the differences are qualitative, and all individuals of one race possess certain genes which are always lacking in the other race, and *vice versa*. Not being a specialist, the writer can only say that a second-hand familiarity with the available evidence suggests that the evidence is quite insufficient and that the problem is best left open. But whatever its solution will prove to be, the environmental plasticity or psychic characters is so great that average differences between races will certainly be smaller than the amplitude of the intra-racial differences.

A Brief Review of the Genetics and Clinical Importance of the Rh Blood Factor

HERLUF H. STRANDSKOV
Department of Zoology, University of Chicago

The Rh blood factor was discovered in 1940 by Landsteiner and Wiener as a consequence of testing human blood with anti-rhesus monkey blood serum developed in rabbits. The human agglutinogen was called Rh because rhesus monkey blood had been used as a source of antigen. By testing the blood of many Caucasoid individuals Landsteiner and Wiener found that about 85 per cent of all members of this racial group possess the factor or are Rh positive (Rh+) and that about 15 per cent lack it or are Rh negative (Rh–).

When a variation such as the presence and absence of the Rh factor is discovered in the human population it is of interest to find out if it has any genetic basis, and if so, to determine, if possible, its mode of inheritance. In 1941 Landsteiner and Wiener reported that variations in the new blood factor are completely genetically determined and that they are due to variations in a pair of

autosomal alleles or genes, that is, a pair of genes with their locus on one of the 23 pairs of non-sex chromosomes or autosomes as they are called. According to Landsteiner and Wiener the allele for the Rh positive condition is dominant over the one for the negative. The dominant gene they appropriately designated *Rh* and the recessive *rh*. Accordingly an Rh negative individual is homozygous recessive *rhrh*, and an Rh positive individual may be either homozygous dominant *RhRh* or heterozygous *Rhrh*. These genetic conclusions of Landsteiner and Wiener were based on a study of 60 families with 237 children involved. In 1943 Wiener and Sonn extended this genetic study to 40 additional families with 138 additional children, giving a total of 100 sets of parents and 375 children tested. The combined results of these two investigations are shown in table 1.

TABLE 1

Types of matings	Number and percentage of families			Number and percentage of observed and expected children					
				Rh positive			Rh negative		
	No. Obs.	% Obs.	% Exp.	No. Obs.	% Obs.	% Exp.	No. Obs.	% Obs.	% Exp.
Rh+ × Rh+	73	73.00	72.25	248	66.13	66.62	16	4.27	5.63
Rh+ × Rh−	20	20.00	25.50	54	14.40	18.38	23	6.13	7.12
Rh− × Rh−	7	7.00	2.25	0	0.00	0.00	34	9.07	2.25
Total	100	100	100	302	80.53	85.00	73	19.47	15.00

Whether or not an hypothesis is to be accepted as a theory depends, of course, upon an acceptable agreement between observed results and those expected according to the proposed hypothesis. The expected percentages of Rh matings between two given genotypes and of Rh phenotypes among their children are obtained as follows:

The best estimate of an autosomal recessive allele in a population mating at random is the square root of the frequency of the homozygous recessive phenotype or in this instance the square root of 15 per cent or 38.73 per cent. The best estimate of a dominant allele, if only two alleles are involved, is 1 minus the estimated frequency of the recessive allele, or in this instance 1 minus 38.73 per cent or 61.27 per cent.

If *Rh* and *rh* alleles have frequencies of 61.27 per cent and 38.73 per cent respectively, in a population mating at random, then we should expect a genotypic ratio in the population equal to the square of the gene ratio (61.27% *Rh*: 38.73% *rh*)^2 or 37.54% *RhRh*: 47.46% *Rhrh*: 15% *rhrh*.

From the estimated genotypic frequency in the population the expected percentages of the different types of Rh matings and the expected percentages of Rh positive and Rh negative offspring can be calculated. The expected percentages of the different types of matings are given by the square of the genotypic ratio, and the expected percentages of Rh positive and Rh negative offspring by a consideration of the genotypes of the parents and their expected percentage contributions to the total number of offspring. These last mentioned expected percentages are also given in table 1.

By a comparison of the observed and the expected percentages it will be seen that the agreement between these two sets of data is good. The degree of agreement can be tested statistically. If we apply the chi square test we find that the differences between the observed and the expected percentages give a chi square value which has a probability well above the conventional 0.05 limit. Hence the proposed hypothesis apparently is acceptable. At least agreement between observed results, based on family studies, and those expected according to theory, is satisfactory.

Although the family studies which have been reported above seemingly warrant the acceptance of the proposed genetic hypothesis, it always is desirable to have confirmation from a somewhat different line of evidence. Recently Strandskov and Diederich examined the

Rh factor among 39 pairs of monozygotic ("identical") and 43 pairs of dizygotic ("fraternal") twins from the Chicago Public Schools.*

The results of these twin studies are presented in table 2. It will be seen that the two members of every one of the monozygotic twin pairs were invariably of the same Rh blood type, that is, either both Rh positive or both Rh negative. This perfect concordance among 39 pairs of monozygotic twins lends credence especially to the conclusion that Rh variations are completely genetically determined. Some of the dizygotic twins were of the mixed type, that is, one member was Rh positive and the other Rh negative. Although these results among dizygotic twin pairs are not, in and of themselves, positive evidence for a complete genetic determination of Rh variations they are not in disagreement with this conclusion.

TABLE 2

Type of twin set	No. of pairs	Rh combination among twins								
		Both Rh+			One Rh+ Other Rh−			Both Rh−		
		No. Obs.	% Obs.	% Exp.	No. Obs.	% Obs.	% Exp.	No. Obs.	% Obs.	% Exp.
Monozygotic ..	39	33	84.62	85.00	0	0	0	6	15.38	15.00
Dizygotic	43	35	81.39	77.22	5	11.63	15.56	3	6.98	7.22

In table 2 are also given the percentages of each type of Rh combination expected among the twins according to the proposed mode of inheritance. If we compare the observed and the expected percentages we find that the agreement is good. A chi square test gives a probability between 0.5 and 0.7 of getting differences as great as those shown. Thus the frequencies of the different Rh combinations among Caucasoid twins also support the proposed mode of inheritance of Landsteiner and Wiener.

Although the establishment of the inheritance of the Rh blood factor is of interest and importance it has probably been the secondary effect of the Rh alleles which has created the most excitement among human geneticists and clinicians. For many years the medical profession has been confronted with a hemolytic reaction of the fetus or newborn child known as *erythroblastosis fetalis*. This disease is characterized by edema, jaundice and anemia and frequently is fatal. Prior to the discovery of the Rh blood factor no causal explanation of this disease was at hand. As early as 1928 Hirszfeld suggested that it might be due to differences in blood groups between mother and developing child. In 1938 Darrow subscribed to this point of view after reviewing the many cases which had been described in the literature. In 1941 following the discovery of the Rh blood factor Levine and his co-workers related erythroblastosis to the Rh factor. They postulated that erythroblastosis fetalis might occur when the mother is Rh negative and the child in utero is Rh positive which, of course, it could be if the father were Rh positive. According to Levine and his co-workers the following events occur: 1) Rh agglutinogens (antigens) from the Rh positive fetus pass *through the placenta into the*

* We are indebted to the Chicago Public School Administration, and to every one of the twins who volunteered, for their generous and wholehearted cooperation.

circulating blood stream of the Rh negative mother; 2) in the tissues of the Rh negative mother the Rh agglutinogens initiate the formation of anti-Rh agglutinins (antibodies); 3) the agglutinins diffuse *through the placenta into the blood stream of the Rh positive fetus;* and 4) in the Rh positive fetus the anti-Rh agglutinins react with the Rh agglutinogens and produce the hemolytic reaction of the fetus or newborn child known as erythroblastosis fetalis.

That all cases of erythroblastosis are due to variations in the Rh blood factor seems probable now. Nearly all erythroblastotic infants have been shown to be Rh positive and the mothers to be Rh negative. Furthermore, Rh agglutinins have been detected in the blood stream of many of the mothers of erythroblastotic infants. The seemingly exceptional cases can probably be explained entirely satisfactorily on other grounds.

Of interest is the question of the incidence of erythroblastosis. If the Rh positive and the Rh negative blood reactions have frequencies of 85 per cent and 15 per cent respectively in a population, and if the variation involves a pair of autosomal alleles with dominance relationships, we should expect about 9 per cent of all babies to be Rh positive and have an Rh negative mother and therefore to be potential erythroblastotics. Fortunately the incidence of the disease is not nearly this high. Apparently in only a small percentage of the potential cases does the hemolytic reaction actually occur. According to Potter erythroblastosis develops in about 1 in 40 infants for whom the possibility of its occurrence exists. She estimates its incidence among all births to be about 1 in 400.

Why erythroblastosis occurs in some potential relationships and not in others is not known. It is, however, known that if the hemolytic reaction has occurred in a family its probability of recurrence in that family is very high. In fact, Potter states that every subsequent Rh positive child in the family will be affected.

Recently Wiener, Levine and their coworkers have discovered that subdivisions of the Rh blood factor exist. These subdivisions have also been shown to have a hereditary basis. It seems too early to state specifically the number of subdivisions or types which occur, but apparently all of them are due to genetic variations at the originally discovered Rh locus. Wiener has postulated that 6 alleles exist instead of only 2 as was suggested originally.

Not only have the Rh subdivisions been shown to have a hereditary basis but they have also been shown to have different frequencies among different racial stocks, that is, among Caucasoid, Mongoloid and Negroid populations. This means, of course, that the different alleles have different frequencies in these populations.

Since erythroblastosis frequently is fatal it is of interest to consider what effect this selection pressure has on the gene frequency of a population. It will be recalled that an erythroblastotic infant is Rh positive but has an Rh negative mother. Consequently the fetus must always be heterozygous, that is *Rhrh*. Therefore selection is against the heterozygote, which means, of course, that both a dominant and a recessive gene is eliminated from a population every time selection operates. If the two alleles involved were equally common in a population neither would decrease or increase in frequency, but this would not be true if they were present in unequal proportions. In that event the less common allele would suffer a proportionately greater decrease. Until the frequencies of the different alleles in different populations are more accurately determined it is futile to speculate further about the exact rôle of selection relative to the Rh factor.

The discovery that the Rh agglutinogen will initiate the formation of agglutinins in the human system has made it important that the Rh factor be considered in blood transfusions. This especially is true if repeated transfusions are to be given. We also appreciate now that an erythroblastotic infant which survives should not be given Rh positive blood. If the child is to be given a transfusion the transfused blood should be that of an Rh negative individual but not that of its own Rh negative mother, nor that of any other Rh negative individual who has developed Rh agglutinins.

Not only has the discovery of the genetics of the Rh blood factor helped us understand the etiology of erythroblastosis fetalis but it has contributed one more blood character which can be utilized in the solution of legal cases involv-

ing disputed parentage. Furthermore it has contributed one more criterion for the determination of the zygosity of twins who are to be used in a determination of the relative rôles which heredity and environment play in the determination of variability among other human characteristics. An analysis of racial differences in Rh alleles should also contribute to our knowledge of racial similarities, racial differences, and racial interrelationships.

Since erythroblastosis is a very unfortunate event in the life of any family and since it seemingly is due entirely to variations in the Rh factor which have a genetic basis, the question is frequently asked if it would not be possible to prevent, by means of eugenic measures, the occurrence of this condition of the fetus or newborn. If our suggested genetic explanation is correct then this would be possible. It could be done by prohibiting either Rh positive or Rh negative individuals from marrying, or at least from having offspring. Such an extreme measure, however, has no justification. The hemolytic reaction could also be prevented by prohibiting Rh negative women from marrying Rh positive men, or if they do, by prohibiting them from having children. Again, however, the incidence of erythroblastosis, even among the children of such marriages, does not warrant such a drastic step. The most that should be done at the present time is to inform all parents or prospective parents of the genetic and clinical facts which have been discovered relative to the Rh factor. Parents who have had one etrythroblastotic child should, without fail, be apprised of the fact that any subsequent Rh positive child is almost certain to be born on erythroblastotic.

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THE GENETICS ISSUE

In a special issue, this column would ordinarily be written by the guest editor, but in this particular instance the guest editor is making his contribution by writing an article on a subject for which his training and teaching experience qualify him particularly well—materials for the teaching of genetics. Dr. Colin was too modest to mention it in his article, so I'll include it here: his book, *Elements of Genetics*, published in 1941 by The Blakiston Company, is an excellent source of teaching aids and suggestions for high school teachers. The book is intended for use as a college text, but it contains a wealth of items of information that help to make the study of genetics interesting and significant, no matter what the teaching level is.

We have tried in this issue to present some of the practical, some of the tech-

nical, some of the basic and fundamental and some from the frontiers of new knowledge. As in the case of the *Vocational Biology Issue*, the papers are by invitation. Since those who are in a position to furnish authoritative information in the dynamic and rapidly growing field of genetics are usually connected with colleges and universities, most of the papers in this issue come from that source. The short items were submitted by an individual who forgot to sign his name; if he will identify himself, we shall give him credit in a future issue. (In case he intended to remain anonymous, we thank him anyway for his interest and effort.) Such items are of value in the general issues, and we need a lot more of them for the By The Way column—don't hesitate to send them in.

Several suggestions for further special issues are in the hopper. The only one for which even preliminary plans are under way is *Laboratory Aids and Substitutes*. Needless to say, all readers are invited to submit their suggestions and contributions. As long as the special issues continue to meet with the general approval they have enjoyed thus far, the editorial board will of course continue them.

John Breukelman

CHARLES B. PRICE

The staff page of The American Biology Teacher for January, 1940 carried for the first time the name of Charles B. Price, as Assistant Managing Editor. This was *Number 4* of *Volume 2;* the journal was really an infant at that time. The first editor, I. Alex Herskowitz, of New York City, was still at the helm. In March, 1941, following the resignation of Alexander A. Fried, "Brad" Price assumed the position of Managing Editor, which he has held to the present time. From *Volume 2, Number 4* to *Volume 7, Number 6;* a period of service of more than five years, in a job of major responsibility—the Association and the Journal, as well as the individual members and readers, owe "Brad" a great deal. He carried on the varied and complicated activities in a quiet and efficient manner, always with a high degree of accuracy and always on time. It was a pleasure to work with him, and we hereby assure him that even though he is no longer an official editor we shall seek his counsel for a long time to come.

Perhaps we may be forgiven a backward look on this occasion. When "Brad" Price stepped in as Assistant Managing Editor, more than five years ago, the following were on the list of Associate Editors: Ruth A. Dodge, Philip E. Foss, Elwood D. Heiss, Melvin A. Hintz, Charles C. Herbst, Ray Kennelty, M. C. Lichtenwalter, M. A. Russell, Ruth Sherman, J. A. Trent, Helen Trowbridge, B. Bernarr Vance and Guy F. Williams. All of these have been on the job ever since and are always ready to respond whenever there is a task for them. More than half of the Associate Editors of five years ago still actively on the job—this is a record that testifies to the vitality of the organization. No doubt at the end of another five years, another backward look will reveal a similar degree of continuity of service.

Once more, thanks, Charles B. Price, for a difficult task excellently done.

Chromosomes, as regular structural parts of cells, were not known until a decade after Mendel's famous experiments.

The word *Mutation* was introduced into the literature of genetics by Hugo De Vries, Dutch Botanist, in a book published in 1901.

Among bees, fertilized eggs develop into female individuals, unfertilized eggs into males; a drone therefore has no father and no sons, but has a grandfather and may have grandsons.

Materials Used in Teaching Genetics

E. C. COLIN
Chicago Teachers College, Chicago, Illinois

Genetics, like other branches of biology, is taught most effectively to beginners by means of demonstrations, observations, and experiments. I have yet to see the student whose interest is not aroused by judiciously selected materials. My experience is in entire agreement with that of Dr. Blakeslee, as described in this issue, in indicating that the degree of retention varies directly with the use of concrete objects. As teachers, our greatest fault probably is too great dependence upon the printed and spoken word.

I should like to mention briefly the materials that I have found useful in teaching the principles of genetics. It is to be hoped that readers who have proved additional instruments of instruction will share their discoveries with the readers of this journal. To facilitate reference, the items are listed below under the genetic principle which they illustrate.

The mechanism of sexual reproduction in plants. The flower of the pea (either the edible pea or the sweet pea), or of some other seed plant, is issued to the students for study and dissection. Such study may well be supplemented by large scale models and charts.

Mendel's first law (Segregation). Permanent display bottles of seeds of several kinds of peas, especially those mentioned by Mendel, are passed around the class for observation. From a seed house the following kinds, among others, were obtained: round yellow, round green, wrinkled yellow, wrinkled green, grey-brown seed-coated. The bottles were tightly stoppered, the corks cut off, and the necks of the bottles dipped in melted paraffin.

Ears of corn, produced by self-pollination of hybrid plants, showing Mendelian ratios of seed characters, on the cob, are distributed for study. A fairly accurate count can be made without shelling the corn. These ears, as well as the next item, are procurable from several dealers. By using a tight metal can and a few moth balls the ears have been kept in good condition for years.

Corn seedlings, segregating for green and albino in a ratio of 3:1, are produced by planting F_1 seeds. To obtain respectable ratios at least 100 seeds should be planted, from stock not more than one or two years old.

Drosophila crosses between easily classified and viable stocks. The *Drosophila Guide*, mentioned by Mr. Miller in this issue is indispensable; it is a 51-page booklet, filled with excellent illustrations and valuable information.

Cat skins, showing a variety of coat colors, were obtained from the comparative anatomy classes. Excellent pelts resulted from tacking out, scraping, and salting the hides.

A few cages of living guinea pigs illustrating coat colors, eye colors, and hair direction in rodents are kept for demonstration. Matings are made in order to produce a few litters during the semester.

Leaflets for testing taste differences with P.T.C., as described by Dr. Blakeslee in this issue, are passed out, and students are asked to test their families.

Mendel's second law (Independent assortment). Much of the material listed under Mendel's first law can also be used to demonstrate this principle: there are ears of corn showing independent assortment of colors and form of seed (starchy vs. sugary); guinea pigs showing assortment of coat colors and hair direction (rough vs. smooth); dihybrid matings of Drosophila, etc.

The chromosome mechanism. Microscope slides showing mitosis in plants and animals (root tips, Ascaris, and whitefish) are effective. These are supplemented with models and charts.

The factor principle and multiple alleles. Ears of corn, showing colors resulting from the interaction of several genes, in numerous modified ratios, are used. With Drosophila, a very successful mating has been between the mutants brown and scarlet. The F_2's give a 9:3:3:1 ratio of red, brown, scarlet, and white; the double recessive eliminates all pigment from the eye. Guinea pigs are used to show that coat color results from the interaction of several independent genes, some of which occur as multiple alleles.

Students are tested for the A-B series of blood groups. Anti-A and anti-B sera are obtainable at reasonable cost from the supply houses, and the test is simply and rapidly applied without special training. This is an excellent example of differences due to a series of triple alleles.

Sex determination and sex linkage. Slides of sections of the testes of the classic bug *Anasa tristis* (see Wilson, *The Cell in Development and Heredity*) are used to show two classes of spermatocytes—those with 11 chromosomes and those with 10.

Drosophila cultures showing F_2's from a P_1 cross between eosin-miniature and Bar are excellent to demonstrate sex-linkage as well as crossing-over.

Students are tested for color blindness by means of the Ishihara plates. In accordance with expectancy, about 8% of the boys and 0.5% of the girls (Caucasoids) have proved to be more or less defective for the red-green sense. The statement is sometimes made that girls are not color blind. In one class I discovered two cases: one was so-called "red blind"; the other was "green blind." Incidentally, these two girls were very inefficient in classifying eye-colors in the Drosophila experiment with brown and scarlet.

Environmental effects. Corn seedlings, segregating for green and albino, are grown as a controlled experiment, in which one half of the population is denied light, with interesting results (see this journal for Dec., 1942).

An albino guinea pig kept in the laboratory develops much sooty pigment on nose, ears, and feet in the winter time, and loses it when the weather grows warm. Low skin temperatures (the laboratory sometimes goes below 50 over the week ends) are known to induce pigment formation in albino guinea pigs—a case similar to, though not so extreme as, the Himalayan rabbit and the Siamese cat.

Ears of "sun red" corn in which the husks were removed in part during development are red in the exposed regions and white in the covered areas.

Most of the foregoing items have been used successfully in a single semester in a college course in genetics. It is realized that only a few can be utilized in a course in general biology. It is hoped that the list may prove helpful to readers in selecting materials adapted to their respective classes.

Teachers Talk Too Much

A Taste Demonstration vs. A Talk About It[1]

ALBERT F. BLAKESLEE
Department of Botany, Smith College, Northampton, Mass.

That teachers talk too much, at least college teachers, has been a growing conviction. The difference in effectiveness between a student's own experience and a teacher's description has been forcibly brought to the writer's attention by a recent talk which he gave at a Smith College Assembly.

The title might have been given as *Differences between People, and the Significance of These Differences in Education and Other Human Relations.* As a basis for the discussion a taste demonstration with *P.T.C.* (*Phenyl-thio-carbamide*) was given. When those who found the crystals tasteless were asked to raise their hands, a murmur of surprise went up from the rest of the audience of 2,000 girls, most of whom had found the taste unpleasantly bitter. They could believe us when we told them that some people we had tested needed to have the solution of P.T.C. 8,000 times stronger than others in order to taste it. When it was explained that the inability to taste the crystals of P.T.C. is inherited according to Mendelian laws, in the same way as are blue eyes, they could admit that a major proportion of our mental capacities as well as those of our senses and our physical features are probably innate and similarly subject to the known laws of inheritance. They could agree that no human beings are alike or ever have been. They could perhaps realize, therefore, that each of us really lives in a different world, at least so far as our sensory reactions are concerned.

The students were asked to draw their own conclusions from the taste demonstration; but a few suggestions were offered regarding the function of a college education. Many reasons for going to college have been given by students, but the best, we said, would seem to be: "To learn to dispense with college professors." In college, if not before, one should learn to think for himself. The term, "Alma Mater," with its implications of a wet nurse, does not rightly set forth the ideals of an institution of higher learning. The college should be a weaner and not a feeder. The plea was made for greater independence among college students.

It seemed to be a good speech, at least I felt it was better than my average, and several people that same day complimented me on it—but not during the days to follow. What I said was apparently quickly forgotten, but this was not true of the taste of the P.T.C. Even now, nearly two years after the assembly referred to, when I am introduced to a group of the college girls I have been accustomed to expect one of the upper classmen to say "Oh, yes, we know you. You are the professor who gave us that awful-tasting stuff in assembly that some of the girls couldn't taste at all." They still seem to taste bitter—some even to feel bitter about it. I doubt, therefore, if the demonstration gained me any personal popularity. Less frequently, the speaker would be a nontaster and remark upon the fact that many of her friends found the taste strong and objectionable, when she herself could not taste the substance. At least one of the students confessed that the demonstration had convinced her that she could not distinguish between the taste of bitter and sour. This we had found to be a not infrequent type of taste indiscrimination.

[1] *Contributions from the Department of Botany*, Smith College, New Series, No. 16.

Recently I have asked some of the students who have spoken to me about the taste demonstration what I said in my talk. From the attempted replies it is quite evident that my words had been easily forgotten but that the taste demonstration and its implications had made an unforgettable impression. Members of the faculty whom I questioned, though more embarrassed than the students, had little better memories of what I said. I still feel that COLLEGE IS A WEANER, NOT A FEEDER, would be a desirable motto to be carved above the entrance to a progressive college and that TO LEARN TO DISPENSE WITH PROFESSORS IS THE AIM OF HIGHER EDUCATION would be an appropriate motto for a students' building.

One of my students, Miss Peggy Lieb, was stimulated by my inquiries to make a little census of her friends regarding my assembly talk. Of 12 whom she questioned, 6 remembered absolutely nothing that I said and 6 remembered I had said something about people having different reactions to the taste substance. None of the 12 remembered any of my remarks about the significance of individuality in college education or other human relations. All 12, however, remembered how surprisingly different the students reacted to the substance which was given them.

The results of this assembly talk, though extremely unflattering to me, emphasize the value of the student's own experience over mere talk about it, however instructive and interesting the talk may be—in the mind of the talker. This is the basis of laboratory experience as an integral part of the instruction instead of lectures alone or lectures with demonstrations by the teacher. I do believe that the P.T.C. demonstration test, when properly conducted, is one of the most effective means of getting people to realize that normal individuals may be extremely different in innate capacities and to draw correct conclusions from this realization.

In accepting your editor's invitation to write an article on experiments with taste, our chapel talk experience suggests it will be more profitable to explain the manner of giving one of these taste demonstrations than to write a review of researches on taste. Almost any tasteable substance will show differences in respect to people's taste acuteness. Some substances, however, are much better than others. An ideal substance should have a relatively sharp reaction, that is to say, the subject should not be in doubt regarding whether he tastes it or not. *Saccharin*, for example, has to most a sweet taste and at the same time, a bitter taste. The sweet taste, however, is often a fleeting reaction. A subject would often say, "I thought it was going to taste sweet," but would not be sure whether to call it sweet or not. Another desirable characteristic in a substance for taste demonstration is a wide range of differences in the reactions of people to it. This may show in people perceiving different tastes in the substance, as is true of *mannose*. It may also show in the range of thresholds or concentrations at which the taste is first detected when given in increasing strengths.

P.T.C. stands out preeminently so far as the substance with the widest range of thresholds among subjects tested, and also usually shows sharp reactions. When a threshold is reached, the subject is usually in no doubt about whether he tastes it or not. There is also another advantage in the use of P.T.C. in that the commercial crystals are of a size which separate people into two groups, those who can, and those who cannot, detect taste in these crystals. The "nontasters" of the crystals pass on their taste inability to their offspring in the same way in which blue eyes are transmitted. Furthermore, this group of nontasters is relatively large, about one-fourth of the population, so that it has been possible to demonstrate the inheritance of taste capacity and incapacity in respect to P.T.C. by the use of the commercial crystals alone. More refined work has been done by securing for each subject the threshold at which he could first detect taste in a series of solutions of P.T.C. of increasing concentrations,[2] but the crystals are more convenient for demonstrations.

[2] SALMON, T. N., AND BLAKESLEE, A. F., *Proc. Nat. Acad. Sci.*, Vol. 28, pp. 78–83, and pp. 84–90, 1935.

The first public demonstration of the use of P.T.C. was at the New Orleans meeting of the A.A.A.S. in 1931, which was organized by the writer in cooperation with Dr. A. L. Fox of the Dupont Company, who had first discovered the peculiarity of crystals of P.T.C. in respect to "tasters" and "non-tasters." This demonstration was described in the *Journal of Heredity*.[3] The demonstration seemed to be a success in showing the wide range of differences of people in their taste reactions, but there were many ways in which it was poorly organized. The exhibit was too elaborate. There were too many charts showing details of taste records which had been taken and there were charts which pointed out the moral which the taste tests were believed to show. At the exhibit it was observed that people simply did not read these charts. If a person asked questions it was possible to show him the answer in some of the detailed records, but few if any went to the records in the charts at their own initiation. The considerable labor involved in making these charts, therefore, could have been profitably avoided.

Another saving could have been made in the quantity of P.T.C. given to each person who visited the exhibit. The crystals were supplied in gelatine capsules and it took considerable time to fill the capsules for between 2,000 and 3,000 people who took the test. So large an amount of the crystals was also a disadvantage in that, despite instructions printed on the envelope which contained the capsules, some people would put in their mouth the full amount of crystals and get extremely unpleasant reactions from so large a quantity. A peppermint life saver was provided to help take away the taste of those who had strong reactions to the crystals. This would not be necessary if a smaller amount of the P.T.C. were taken.

One element in the demonstration appeared to be of considerable exhibit value; namely, the use of a voting machine. It was originally intended that those who took the test would record their own votes. However, sometimes several a minute took the test and needed to be recorded so it was found necessary for different people taking the test to report their reactions to an attendant who recorded for them on the machine. In addition to rapidly recording, the machine had another advantage in that the noise it made attracted people in the exhibit hall and undoubtedly increased the number of people who took the test. It has accordingly been used effectively in other similar demonstrations.[4]

In connection with the Eugenics Congress in 1932 a voting machine was used in a taste demonstration exhibit at the American Museum of Natural History and records were obtained of over 6,000 persons. The P.T.C. was given out in small strips of paper which had been impregnated with P.T.C. Such paper for class use is for sale at a nominal charge by the *Journal of Heredity*, Victor Building, Washington, D. C. The effectiveness of this second exhibit was increased by a great reduction in the numbe of charts.

We have made up P.T.C. paper by running ticker tape through an alcohol solution of 0.02% of P.T.C., drying the paper by passing it over hot plates and winding it up on a movie camera reel. This concentration of P.T.C. when an inch or half an inch of the paper is chewed gives about the same reaction as do the commercial crystals in dividing the population into two groups of "tasters" and "non-tasters." By making the alcoholic solution of P.T.C. more

[3] Blakeslee, A. F., and Fox, A. J., *Jour. of Hered.*, Vol. 23, pp. 96–107, 1932.

[4] Blakeslee, A. F., *Sci. Monthly*, Vol. 41, pp. 72–84, 1935.

concentrated, a higher proportion of people will be able to taste the ticker tape and if the tape is prepared with a saturated alcoholic solution of P.T.C., there will be few, if any, people who cannot taste it. Thus by making up paper with the proper alcoholic solution, one may secure either a high or a low proportion of "tasters" in a group of subjects. It is fortunate that the commercial crystals are of a size which divides the population into two convenient groups. Those who wish to make up their own P.T.C. paper, may purchase the crystals from the Eastman Kodak Company. The disadvantage of the paper is that there is a pellet of chewed paper left after the test is taken. Another disadvantage in the use of impregnated paper is the fact that this chemical is somewhat volatile so that within a year the P.T.C. paper which was sent around with the *Journal of Heredity* article already referred to had lost all taste, even to the most acute subjects.

Another taste demonstration exhibit was given at the Richmond meeting of the A.A.A.S. in 1938, with mannose. It was found that if mannose were diluted with an almost tasteless substance, *satin gum*, in the proper proportion it could be used in getting a wide range of different reactions from people. In the Richmond demonstration we used tablets made up by John Wyeth and Brothers, each containing 5 mgm. of mannose and 25 mgm. of satin gum. Of the over 3,000 people who took this test, 29% got no taste; 36% found the taste sweet only; 11% bitter only; 3% sour only; 1% salty only; 9% sweet followed by bitter; 3% bitter followed by sweet; 8% found other combinations of tastes in the tablets. These mannose tablets are also for sale by the *Journal of Heredity*. They are capable of giving an interesting range of differences in the reactions of a group of students.

As a method of giving out these tablets of mannose, various pill dispensing machines were investigated. It was finally found simpler to pour the pellets into a dish and to have an attendant pick one out, with a pair of forceps, for each subject.

There is a distinct advantage in giving

TASTE CENSUS

Under Auspices of Four-College Genetics Conference
WHAT IS TASTE OF P. T. C. (Phenyl-thio-carbamide)?

Name_____ Sex_____ College_____ Date_____

Mark X in proper space in each group below.

1. Class:

Freshman	Sopho-more	Junior	Senior	Graduate School	Faculty and Administration

2. Taste of Crystals is:

Absent	Sweet	Sour	Salt	Bitter	Other taste (specify)

a demonstration at the same time to a relatively large group of subjects, and to have the record of their reactions shown by a raising of hands. With a group of students, more readily than with a mixed audience, it is possible to have questionnaire sheets filled out. A copy of the questionnaire used in our last assembly talk is appended. Clipped to this was a glassine envelope $2\frac{3}{4}$ by $1\frac{3}{4}$ inches which contained barely enough P.T.C. to be visible. We found about 3 milligrams of the crystals per envelope to be adequate. The questionnaires with the P.T.C. were placed, one in each seat, before the assembly and were collected as the students left the building. A distinct improvement would have been to give a warning in the questionnaire not to taste the crystals until the test had been explained. Many put all of the crystals into their mouth without waiting for instructions and even though the quantity in the envelope was minute it gave to some students a too violent reaction. The records of this test were turned over to the students' Biological Club for tabulation and report in the college paper and were available for later detailed tests of those who reported unusual reactions. Of the total 1,697 who filled out blanks, 20 per cent found the P.T.C. tasteless, 0.4 per cent sweet, 3 per cent sour, 3 per cent salt, 70 per cent bitter and 3.5 per cent some other "taste," which was usually an odor.

In asking for a show of hands on the different tastes experienced, it is desirable to call first for those who get no taste, then for the less frequent tastes of sweet, sour and salty, and finally for those who taste bitter. There appears less hesitation to raising the hand for an uncommon taste after the heavy vote for "No taste" and before the majority vote for "Bitter."

The reactions to P. T. C. have been used as a subject for sermons in a number of cases. It is possible that profitable use could be made of such a taste demonstration in the way of themes in which the student could point the morals to be drawn in different fields of human activities. P.T.C. is not rationed. We believe that a few pounds used in such demonstrations as we have described would be of more value to students than an equal number of tons of the usual run of didactic text books.

Hatching Individual Frog Eggs in Test Tubes

JAMES PERKINS SAUNDERS
Northbridge Senior High School, Whitinsville, Massachusetts

Shhh . . . Listen! Can it be that Spring is *really* here? Yes! There are the frogs, singing merrily, as they return to "this world" after a winter-long hibernation. Now is the time for an annual biology class project—a project that always arouses great interest among the biology students.

Batches of frog eggs, with buckets of the pond water in which they were found, are hustled to the laboratory. Each student is given a test tube half filled with the pond water. One by one they file to the lecture table to receive *one* frog egg popped out by hand from the large jelly-like mass of eggs. A small label with the student's name and section is attached to each test tube for identification.

Each student is given a tripod magnifier and a cork stopper. The stopper is placed in the end of the test tube so

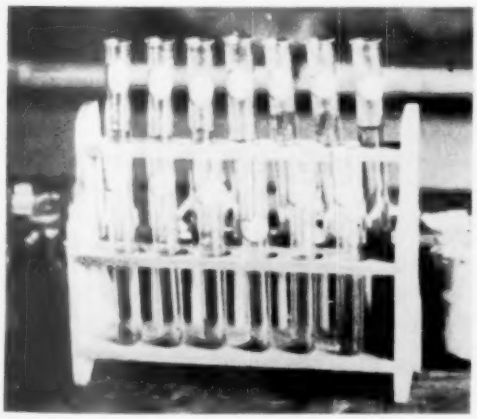
that it may be placed horizontally on the desk. The tripod magnifier is placed over the test tube and focused carefully.

After class discussion of the embryological development of the frog, students examine the embryo through the magnifier to determine its condition at the start of the project. The stoppers are then removed and the test tubes placed in racks on the laboratory tables to await the next inspection the following day.

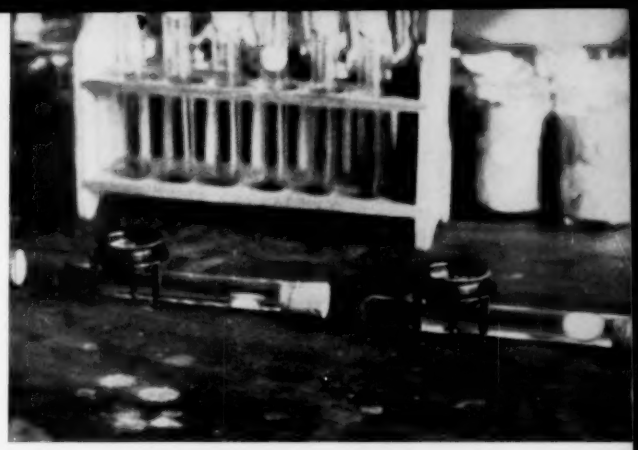
Day by day the process of examination of the embryo under the magnifier continues. Students are carried along by the enthusiasm engendered by the uncertainty and mystery. Step by step *life* is unfolding before their eyes. Larger and larger grows the embryo.

Suddenly, a spirited cry of excitement breaks the comparative quiet of the classroom. Investigation shows that an embryo has become a larval form—the tadpole has *hatched*—right before the eyes of the student. Excitement increases—all students are hoping that they too can be lucky enough to see this all-important event for themselves.

After hatching, the tadpole is fed with small amounts of pond scum while it remains alive in the test tube. The daily examination continues as long as life continues. Some are transferred to larger aquaria to more nearly insure continuance of life.



Test tube rack filled with test tubes each containing *one* frog egg. Label on tube has student's name and section for identification. Some students become so attached to their "spark of life" that they give them nicknames which are also written on the labels.



Individual test tubes with cork stopper in the end placed horizontally on the table. Tripod magnifiers placed over the tubes and focused carefully so that the embryo may be clearly seen.

In our classes we have had between fifty and seventy-five per cent of our eggs actually hatch in the student's test tubes. A smaller per cent have actually grown larger.

Here is an interesting project in *life* for your biology classes. It is easily carried out, excites the greatest interest, and at the same time really *teaches*.

CONCERNING DDT

The first official statement by the entomological profession on the new insecticide, DDT, was issued December 15, 1944, by the *American Association of Economic Entomologists*, closing its 56th annual meeting.

Adopted by 392 delegates representing 1600 members, it was offered both to summarize results of intensive research, revealed in the past day and a half of reports to the convention, and to correct "misunderstanding, over-optimism and distorted impressions." The statement follows:

"We feel that never in the history of entomology has a chemical been discovered that offers such promise to mankind for relief from his insect problems as *DDT*. There are limitations and qualifications, however.

"Subject to these, this promise covers three chief fields: Public health, household comfort, and agriculture. As public health we include control of the insects which carry diseases that have scourged humanity, such as malaria, typhus and yellow fever. Household comfort is taken to cover such things as

flies, fleas, bedbugs and mosquitoes. Agriculture includes not only farms, gardens and orchards but forests, livestock and poultry.

"In the public health field DDT insecticides are so much more effective than previous weapons against malaria mosquitoes that for the first time there is a practical hope for eradicating that disease from this country. DDT proved in Italy that it is the first and only practical control for typhus. In the household field its amazing lasting effect promises relief for months from flies, mosquitoes and fleas. In the case of bedbugs, eradication from the American home has become a possibility.

"In agriculture, it is promising against a wide variety of destructive pests. These include most potato insects, many orchard and vineyard pests, numerous vegetable insects, as well as the chief insect enemies of vitally important seed crops. It appears to be effective against the pink bollworm and outstanding against the Japanese beetle, two of our worst imported pests. It promises also a more practical control of the pests which ravage thousands of square miles of forest, and against many of those which harrass livestock.

"DDT will not kill all the important insect pests. It will kill many beneficial insects which are allies of mankind against the destructive species. Because of its toxicity to a wide variety of insects, its large-scale use might create problems which do not now exist. To illustrate, it is a superior insecticide for control of codling moth on apples, but in some sections at least will kill certain natural enemies and thus release other insects which may then become major problems.

"The research reports emphasize that we have not had time to develop entirely satisfactory mixtures and dosages of DDT insecticides, nor the methods and timing of application for many possible uses. Modern agricultural pest control often requires mixing several materials in combination treatments, and we know little of DDT's compatibility with many of these others. Researches thus far were made with a material which was produced under pressure for military needs, and which is not necessarily the best for agriculture.

"We do not know enough about effects on plants, animals and soils. While most plants were not harmed by DDT insecticides in the experiments, injury to squash, corn, tomatoes and possibly fruit trees was reported. DDT is toxic to animal life when large amounts are taken internally or absorbed through the skin from oil solutions, but reports indicate a reasonable margin of safety. In the light of our present knowledge, heavy deposits on edible parts of plants should be avoided. Reports show definite toxicity to cold-blooded animal life including fish and frogs. There has not been time to learn the possible cumulative effects on soils.

"More and larger-scale experimentation is needed. Enough DDT for such research in 1945 should be provided."

The report that was presented to the Association, which is the part enclosed in quotation marks, was signed by the full committee —G. F. MacLeod, F. C. Bishopp, A. J. Flebut, C. E. Palm, G. C. Decker, G. M. List, and S. A. Rohwer, *Chairman*.

POPULATION GENETICS OF LADY BEETLES

The great variability of the color pattern of many species of lady beetles has long been recognized as material for the study of evolution. If the genetics of a given pattern is known, natural populations can usually be analyzed to determine the frequency of the responsible genes. When such frequencies of the same gene are known for many parts of the range of a species, it is often possible to devise a probable scheme of evolution to account for them.

Until recently few attempts have been made to ascertain the genetics of these patterns. The probable reason has been the difficulty of supplying the food, which for most lady beetles is chiefly aphids. The author of this note, having reared aphids in experiments for thirty years, and thus solved the problem of a food supply, has undertaken the genetic studies and application of the results to wild populations. Contrasted characters have been studied for one species in Oregon, for another species ranging from Michigan to California, and for a third from Utah. Other such studies are in progress and still others will be pursued as opportunity arises.

To make the desired applications of the results, it will be necessary to obtain collections of lady beetles from all over North America. Most of these must be obtained through other biologists, for even when travel is again possible, per-

sonal collection will be justified only in special situations requiring detailed study. It is hoped that collections may be obtained from many who see this note. Hibernating masses may furnish very large collections, particularly in the western mountains. Collections made in the active season must usually be small. Live specimens will be needed only occasionally to start new genetic experiments. All collections will be welcomed, and the service rendered to a research project need not be entirely a labor of love or charity.

A. Franklin Shull,
Department of Zoology,
University of Michigan,
Ann Arbor, Michigan

Sixty centuries ago, the Babylonians knew that there were two kinds of date palms and that both kinds were necessary for the production of dates.

A German Botanist, Kolreuter, as early as 1760, did some careful experiments in plant breeding, but he did not succeed in making an accurate analysis of his results.

Books

Grant, Julius. *Hackh's Chemical Dictionary.* 3rd ed. The Blakiston Company, Philadelphia. xii + 925 pp. illus. 1944. $12.00.

This book contains the words generally used in chemistry. There are various lists—such as a list of indicators; tables, for example a table of the periodic chain; and graphs, a graph for isothermals being one. Numerous illustrations of equipment, diagrams of theories, and photographs and diagrams of results are given, which clarify the definitions. Many terms from the related sciences of physics, mineralogy, pharmacy, agriculture, biology and medicine, are included. There are brief biographies of men from various fields of science with portraits accompanying many of them. Formulas are included and the organic ring compounds are diagrammed. The definitions are clear-cut and easy to understand. Each item is fully covered, which necessarily makes some definitions, such as that of an atom or a molecule, quite long. Others are very brief. Two of the shorter ones will serve to illustrate the general arrangement.

bisulfide. Disulfide. A binary compound containing two atoms of sulfur.

rare gases. The noble gases (He, Ne, A, Kr, and Xe).

NOTICE TO CONTRIBUTORS

Manuscripts for publication in The American Biology Teacher should be typewritten, on one side only, on standard white paper, 8½ × 11 inch size, with a margin of at least an inch on all sides. The writer should keep a carbon copy for reference and as insurance against loss of the original in transit.

Articles are scheduled for publication in approximately the order of acceptance of the manuscripts. Generally the journal is tentatively arranged about three or four issues ahead, and there are under consideration at any time enough manuscripts for about two or three more issues. Some space is of course allowed for news items and articles of a seasonal nature. The manuscripts for this issue were submitted last summer and fall. On the average, a manuscript submitted this month may expect to find its way into print, if it is accepted promptly, in about December or January. Many seasonal papers have to be postponed an entire year, simply because the author has not allowed the necessary four to six months that intervenes between acceptance and publication.

For details concerning titling, headings, references, illustrations, etc., consult *Preparation of Manuscripts for Publication*, which appeared in the October, 1943, issue of The American Biology Teacher. A limited number of reprints is still available; copies may be obtained from the editor.

Manuscripts may be sent to the editor-in-chief or to any one of the associate editors. A complete list of the latter appears in each October and February issue.

While this is fundamentally a chemical dictionary, it contains enough information about biology to make it a very worthwhile addition to any biologist's library. Some examples follow.

biology. The science of living matter, its forms, functions, occurrence, behavior and evolution. Branches of biology:
1. Botanical branches (plants).
2. Zoological branches (animals).
3. Anthropological branches (man).

A table of all the divisions and sub-divisions of biology follows this definition.

karyokinesis. The phenomena of cell-division or mitosis, during which the protoplasm of the cell and its nucleus undergo a series of changes which are subdivided into a number of phases merging from one into the other (see figure).

JEAN SCOTT MACFARLANE,
State Teachers College,
Emporia, Kansas

RODGERS, ANDREW DENNY III. *American Botany.* Princeton University Press. 340 pp. 1944. $3.75.

American Botany is another in a series of books, by this author, covering the development of botany in America during the nineteenth century. Biographies of John Torrey and William Sullivant have already appeared. The present volume covers the vital transition period of 1873 to 1892, in which the contributions of Asa Gray dominate the field of American botany. Most of the material was taken directly from letters and unpublished correspondence of Doctor Gray. Students of American botany as well as those interested in the history of science in general will welcome this well-written volume.

J. A. TRENT,
Oklahoma Baptist University,
Shawnee, Oklahoma

LADY BEETLES WANTED

The undersigned is prepared to buy collections of lady beetles from anywhere in North America. Dry specimens will usually suffice; only occasionally will live beetles be needed. Offers are invited.

A. FRANKLIN SHULL, *Dept. of Zoology*
University of Michigan Ann Arbor, Mich.

NOTE

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